NEXT GENERATION SPACE TELESCOPE

SUPPORT SYSTEMS MODULE
OFF-SITE @ STScI

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NEXT GENERATION SPACE TELESCOPE

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NGST SSM* OFF-SITE AGENDA

<u>DAY 1</u>: The Information

● Top Level Science Drivers	Mather / Stockman	3:00 - 3:30
● Top Level Systems Drivers	Seery	3:30 - 4:00
● OTA Baseline Concept	Beaman	4:00 - 4:30
● Science Instrument Module	Bely	4:30 - 5:00
● Goals for the Off-site and Change to the Working Group	Seery	5:00 - 6:00

*Support Systems Module

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NGST SSM* OFF-SITE AGENDA (CONT)

DAY 2: **The Work**

● Candidate Operations Scenarios	Kalinowski	9:00 - 9:30
● Working Session #1	Group	9:30 - 10:30
● Break	_____	10:30 - 10:45
● Working Session #2	Group	10:45 - 12:30
● Lunch	_____	12:30 - 1:15
● Working Session #3	Group	1:15 - 3:00
● System Re-composition	Group	3:00 - 4:00

*Support Systems Module

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STEPS IN THE IPT DESIGN PROCESS

1. Acknowledge the science drivers which have been binned by levels (eg. Level 1, 2, 3, 4).
2. Acknowledge those aspects of the observatory that are essentially a “given” (eg. L2, no EVA, ATLAS IIA).
3. Identify all of the major interfaces that the spacecraft team must service.
4. Identify and scope all of the major tasks that the spacecraft team must accomplish.
5. Identify and prioritize key design and technology drivers.
6. Identify top-level system requirements - where there are none or they are ambiguous, say TBD.
7. Identify major trades and concept evaluation criteria.
8. Develop strawman end-to-end observatory functional concept.
9. Decompose strawman to the subsystem level and examine the trades and impacts.
10. Recompose to the systems level.

NGST CONCEPTUAL DESIGN STUDY PRODUCTS

- ONE POSSIBLE STRAWMAN OBSERVATORY DESIGN CONCEPT SUPPORTED BY A FEASIBILITY ESTIMATE
- ROM ESTIMATE OF RESOURCES
- A VALIDATED AND REFINED SET OF MISSION OBJECTIVES AND REQUIREMENTS
- A SET OF PRIORITIZED AND WEIGHTED CONCEPT EVALUATION CRITERIA
- TECHNICAL TALL POLES AND RISKS
- TECHNOLOGY DEVELOPMENT ROADMAP
- TECHNOLOGY RISK MITIGATION (VALIDATION) PROGRAM
- INTERIM AND FINAL REPORT DOCUMENT

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THE CONSTRAINTS

- **COST OF CONSTRUCTION: $500M**
- **SCHEDULE: PHASE B START IN '03 AND 3-YEAR OBSERVATORY DEVELOPMENT LAUNCH IN '06**
- **LAUNCH VEHICLE: 'MADE IN USA'**

  ALLOCATION COMES OUT OF THE PROJECTED LIFE CYCLE COST OF $900M
- **DRESSLER RECOMMENDATIONS FOR THE BASIS FOR THE SCIENCE MISSION REQUIREMENTS**
- **ADVANCED TECHNOLOGY AND INNOVATIVE SYSTEMS DESIGN WILL ENABLE NGST**
  - **NOT TO MENTION CREATIVE MANAGEMENT TECHNIQUES**

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Top Level Budget Allocations*

COMPONENT	SIZE (m)	WEIGHT (kg)	COST ($M)
OTA	upper 8 (inc. taper)	1000	$100
SIM	2	500	$100
S/C	1	500	$50
OPS	---	---	$45
RESERVE	---	818	$205
CONSTRUCTION SUBTOTAL	11	2818	500

*** Does Not Include Science Data Analysis or Technology Development**

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EVALUATION CRITERIA

- **FLEXIBILITY**
- **ROBUSTNESS**
- **SIMPLICITY**
- **DESIGN MARGIN**
- **MEETS LEVEL 1 SCIENCE REQUIREMENTS. LEVEL 2? LEVEL 3?**
- **COST REALISM**
- **TECHNOLOGICAL READINESS**

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NGST OSM DESIGN DRIVERS

- TELESCOPE TEMPERATURE
- LAUNCH VEHICLE PAYLOAD CAPABILITY
- SHROUD CONFIGURATION
- INSTRUMENT SCIENCE DATA RATE
- GUIDANCE AND CONTROL STRATEGY
- CONTAMINATION AVOIDANCE
- DEGREE OF SPACECRAFT AUTONOMY
- OTA CONFIGURATION AND DEPLOYMENT STRATEGY
- COST
- SCHEDULE (TECHNOLOGY MATURITY)

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NGST RELIABILITY PHILOSOPHY

- **FAULT AVOIDANCE, OR "DO IT RIGHT THE FIRST TIME," IS THE BEST WAY TO MAKE THE OBSERVATORY RELIABLE**
  - **AMPLE DESIGN MARGINS**
  - **APPROPRIATE APPLICATION OF HIGH REL PARTS WHERE NEEDED**
  - **TECHNOLOGY VALIDATION DEMONSTRATIONS IN THE APPROPRIATE ENVIRONMENT**
  - **QA BY THE COGNIZANT OR LEAD ENGINEER**

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NGST RELIABILITY PHILOSOPHY (CONT)

- **FAULT TOLERANCES AT THE COMPONENT LEVEL OR LOWER WHERE REQUIRED; SINGLE STRING EVERYWHERE ELSE**
  - **LESS EXPENSIVE THAN AT THE SUBSYSTEM LEVEL**

CAUSES OF FAILURES

ASSIGNED CAUSE	
DESIGN	24.8%
ENVIRONMENT	21.4%
OPERATIONS	4.7%
RANDOM	
PARTS	16.3%
QUALITY	7.7%
OTHER	6.3%
UNKNOWN	18.9%

NEXT GENERATION SPACE TELESCOPE NGST

NGST STRAWMAN OBSERVATORY CONCEPT

NGST IS AN 8-METER CLASS (7.2M EFFECTIVE; 40M^2 COLLECTING AREA) DEPLOYABLE TELESCOPE, OPTIMIZED FOR THE 1-5μm SPECTRAL REGION, AND WITH 'BEST-EFFORT' SPECTRAL THROUGHPUT FROM 0.5-20μm. THE PRIMARY MIRROR WILL INCLUDE SOME LEVEL OF POSITION, TILT AND HIGHER ORDER WAVEFRONT CORRECTION. THE OTA FIRST ORDER DESIGN IS AS FOLLOWS:

- **OPTICAL TELESCOPE ASSEMBLY CHARACTERISTICS**

APERTURE	8.0m
LIGHT GATHERING POWER	7.2m
FOCAL RATIO	F/10
TELESCOPE IMAGE LOCATION	40cm INSIDE
MAXIMUM OBSERVATION RATIO	20%
FOCAL PLANE CURVATURE	2m RADIUS
PRIMARY-TO-SECONDARY DESCOPE	8.94m
PRIMARY MIRROR FOCAL RATIO	F/1.25
SECONDARY MIRROR FOCAL RATIO	F/1.1
SECONDARY MIRROR APERTURE	85cm
SECONDARY MIRROR MAGNIFICATION	8x
NO. OF DEPLOYABLE MIRROR SEGMENTS	8
DIAMETER OF CENTRAL MIRROR SEGMENT	3.4m
FIELD OF VIEW	5x5 ARC MIN
OPTICS TEMPERATURE	30-40K

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NGST STRAWMAN

- **<u>OBSERVATORY SUPPORT MODULE (OSM) CHARACTERISTICS</u>:**

  'WARM' MODULE, INCLUDING THE SUNSHADE, SOLAR ARRAYS, AND RF ANTENNAS

  - **COARSE POINTING USING XTE-TYPE WHEELS TO THE ARCMINUTE LEVEL**
  - **3-AXIS TRACKERS TO CONTROL FINE ROLL, COARSE PITCH & YAW**
  - **FINE STEERING MIRROR POINTING TO THE 5 MAS LEVEL**
  - **GYROS, COARSE AND DIGITAL SUN SENSORS**
  - **MOMENTUM UNLOADING VIA JETS (ION OR GAS TBD)**
  - **FIXED SOLAR ARRAYS (POSSIBLE CANTED) - ATTACHED TO SUNSHADE (TBD)**
  - **X-BAND HGA, OMNI S-BAND ANTENNAS**
  - **PASSIVE COOLING OF OPTICS AND INSB DETECTORS VIA INFLATABLE 2-SHIELD SUNSHADES**

NEXT GENERATION SPACE TELESCOPE NGST

NGST MODEL SPECIFICATION

PARAMETER	SPECIFICATIONS	GOAL	COMMENTS
OPTICAL SYSTEM			
-COLLECTING AREA	>12m^2	50m^2	EXPOSURE TIME PROPORTIONAL TO D^{-4}
-OPTICAL QUALITY	D.L. AT 2μm		ASSUMES 8m APERTURE, 60-80 MAS FWHM
-WAVEFRONT ERROR	λ/14 rms		STREHL RATIO = 0.8 FOR λ = 2μm
-FIELD OF VIEW	>3' X 3'	4'x4'	
-ANGULAR RESOLUTION	0.06"		CORRESPONDS TO HST LEVELS AT 2μ
-ALIGNMENT (STATIC)	$\leq$ 20% LOSS OF EFFICIENCY		AT EDGE OF FOV
-SENSITIVITY	1.4 nJy		M = 31AB, 10^4 SEC EXPOSURE
-TEMPERATURE	< 70K	30K	T = 600/ λ max
-POINTING	10 mas		~0.1 λ_D AT λ max
-STRUCTURAL FIRST MODE	>30H_Z	>50H_Z	
-JITTER	0.007 "rms		

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NGST MODEL SPECIFICATION (CONT)

PARAMETER	SPECIFICATIONS	GOAL	COMMENTS
OPTICAL SYSTEM			
-CENTER OF MASS - CENTER OF PRESSURE OFFSET	11 cm	5 cm	
-NOMINAL EXPOSURE	10^4 SEC		COMPOSED OF 1000 SEC SUBFRAMES
-SPACECRAFT THERMAL ENVIRONMENT	-10 TO +40°C		
-ROLL REQUIREMENTS	1”		1δ VALUE
-GUIDE STARS	MINIMUM OF 1 $m^Y = 19$	____	95% PROBABILITY
-MAXIMUM DYNAMIC IMBALANCE	TBD		
-COORDINATE SYSTEM	V^1, V^2, V^3		
-SCIENCE DATA VOLUME	TBD		

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NGST MODEL SPECIFICATION (CONT)

PARAMETER	SPECIFICATIONS	GOAL	COMMENTS
OPTICAL SYSTEM			
-GALACTIC COSMIC RAY FLUX	10^{-5}/PIXEL/SEC		ON-BOARD COSMIC RAY REMOVAL BASELINED
-OPTICAL FIELD DISTORTION	TBD		
-BIT ERROR RATE	10^{-6}	10^{-8}	DOWNLINK
-SCIENCE DATA RATE	TBD	~1Mbps	ASSUME X2 DATA COMPRESSION AND CO-ADDING
-COMMAND UPLINK	>2 Kbps		
-AMBIENT RADIATION BKGRD	TBD		
-SOLAR RADIATION BKGRD	3 Krad PER EVENT		BASED ON SOLAR CYCLE 22
-TID	60 Krad		EOL, ASSUMED 2 EVENTS/YEAR

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NGST MODEL SPECIFICATION (CONT)

PARAMETER	SPECIFICATIONS	GOAL	COMMENTS
OPTICAL SYSTEM			
-SPACECRAFT CHARGING	<10 VOLTS		
-CONTAMINATION	100A		10A/yr X 10 YEARS
-REFLECTIVITY LOSS DUE TO ICING	2%/yr		
-OBSCURATION	EOL PARTICLE LEVEL OF 500		
-CRUISE DURATION TO L2	TBD		
-ORBIT ADJUST Δv	MINIMAL		
-STATIONKEEPING Δv	MINIMAL		
-L2 ORBIT RADIUS	$0.5 \leq r \leq 30°$		
-OBSERVATORY LIFE		10 YEARS	
-INSTRUMENT BAY TEMPERATURE	<40K	30K	
-SKY COVERAGE	>20%	>25%	
-PITCH-YAW	5''		